APPENDIX 5-1

INTERIM SUMMARY TECHNICAL MEMORANDUM

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

Evaluation of PMP/PMF and Hydrologic Model

To: Distribution

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1. OBJECTIVE

Projecting the probable maximum precipitation (PMP) event and the resulting probable maximum flood (PMF) provides an important basis for determining other design criteria for the Everglades Agricultural Area Reservoir A-1 (EAA Reservoir A-1). The Hydraulic Engineering Center (HEC) of the U.S. Army Corps of Engineers (USACE) has worked with the National Weather Service (NWS) to develop computer models that will estimate these parameters based on the geographical location and other appropriate physical and climatic conditions.

The PMP Model output predicts the total maximum rainfall for a given area. Using this information, in addition to existing Everglades Agricultural Area (EAA) permitted release rates, the PMF Run-off Model will be able to predict the response of the surrounding watersheds and drainage canals. It will allow us to conceptualize the length of flooding and help to set drainage priorities for the reservoir and the surrounding watersheds.

2. PMP MODEL

Hydrometeorological Report (HMR) Nos. 36, 43, 49, 51, 52 and 55 were developed to analyze data and provide logic and methodology for predicting the PMP for a given area (between 10 and 20,000 mi^2) within the United States (NOAA 1978 & 1982). HMR Nos. 51 and 52 are used for determining PMP east of the 105th Meridian, including the EAA. A computer program, HMR52, was developed which automates the calculations required to follow the procedures in HMR No. 52. HMR No. 52 recommends a procedure for estimating the PMP in an area for which both a temporal and spatial distribution of the precipitation are required (USACE, 1984). This information can then be used for estimating the probable maximum flood (PMF) and Run-off response discussed in Section 3.

2.1 Design Conditions

HMR52 computes basin-average precipitation for PMP taking into account geographical location, geometry of the study area, orientation of the study area, and depth-area-duration rainfall data from HMR No. 51. More detailed information on the HMR52 model, as well as, documentation and model runs are included in the *Model Documentation Memorandum (Draft)* (Schlaman et al. 2005). In addition, HMR Nos. 51 and 52 provide the technical background and justification for the HMR52 methodology (NOAA, 1978 & 1982). The goal of the 5 model runs was to evaluate different variables and determine the conditions that maximize the resulting volume of water.

2.1.1 Study Area and Location

The smaller the area, the greater the rainfall depth, but the smaller the volume of total rainfall received. For this study three different areas were considered in determining the PMP. They are shown in Figure 1. Area A was used for Runs 1, 2 and 3. Area B was used in Run 4 and the EAA Reservoir A-1 was used for Run 5. The EAA Reservoir A-1 is included in Areas A and B and that Area B is included in Area A. Information about the three areas is summarized in Table 1.

These three areas were chosen to investigate the possible PMP depths across the EAA region. The three areas include the North New River canal and Miami canal watersheds (Area A), a smaller portion of these watersheds (Area B), and just the EAA Reservoir A-1. The larger areas were chosen to estimate the maximum precipitation event that would inundate the entire region. This information will be used in order to predict the watershed response from a large storm event and determine the canal conditions in and around the EAA Reservoir A-1. The EAA Reservoir A-1 PMP was developed because there is a possibility that a PMP falls just across the reservoir. Because the storm area will be smaller than the PMP storms for Areas A and B, the PMP depth will be greater. To correctly estimate the appropriate A-1 embankment height in the wave-run-up modeling as well as determine the PMP dam breach characteristics, the PMP across just the EAA Reservoir A-1 needs to be defined.

The following sections discuss the study areas for the HMR52 Runs 1-5. A full understanding of PMP development can be obtained by referring to Hydrometeorological Reports (HMR) 51 and 52 (NOAA, 1978 & 1982). In these reports, several steps are required to determine the PMP for a given watershed. To develop the PMP, a storm with characteristics such as size, location (i.e. storm center), and orientation (how the storm overlays the watershed) must be determined that maximizes the total runoff depth onto the watershed (by definition). The HMR52 computer can be programmed to determine all of these characteristics to maximize the PMP depth. However, manual input can also be chosen to investigate the affects of changing the assumed storm orientation, location, and size. Therefore, HMR Runs 1-5 investigate the results of changing these parameters.

2.1.2 Run 1 – Study Area A Using Model Defaults

Run 1 was developed with Study Area A, shown on Figure 1, as the drainage area. Orientation, storm center and storm area were determined by the HMR-52 model to maximize the PMP depth.

2.1.3 Run 2 – Study Area A with a Storm Orientation of 138 degrees

Run 2 was developed with Study Area A, shown on Figure 1, as the drainage area. An orientation of 138 degrees was chosen from inspection of the drainage area. The storm center and storm area were determined by the model to maximize the PMP.

2.1.4 Run 3 – Study Area A with GIS Determined Centroid

Run 3 was developed using Study Area A, shown on Figure 1, as the drainage area. GIS tools were used to calculate the basin centroid over which the PMP was centered. The orientation and storm area were determined by the model to maximize the PMP.

2.1.5 Run 4 – Study Area B Using Model Defaults

Run 4 was developed using Study Area B, shown on Figure 1, as the drainage area. The model was used to determine the orientation, storm center and storm area.

2.2 Run 5 – Reservoir A-1 Using Model Defaults

Run 5 was developed using Reservoir A-1, shown on Figure 1, as the drainage area. The model was used to determine the orientation, storm center and storm area.

2.3 Model Configuration

HMR52 is a DOS based model. For each run, a separate input file was created that included the assumptions discussed in Section 2.1. See the *Model Documentation Memorandum (Draft)* for hardcopy printouts of the input and output (Schlaman et al. 2005).

2.4 Model Calibration, Verification, and Reliability

Since the goal of the PMP modeling process is to predict the maximum precipitation event for a specific drainage area, there is no historic data that can be used to verify or calibrate the PMP model. HMR No. 51, however, was developed using historic storms as the basis for the PMP projections.

The reliability of the projections, however, can be verified by comparing these results to the results of other PMP projections done in the same area. If the results are similar, this provides confidence in the proper use of HMR52. Table 2 shows the results of similar calculations, provided by other EAA reports.

2.5 Results

HMR52 Model results and 10-minute inflow hydrograph for the EAA Reservoir A-1 are included in Appendices 5-6 and 5-7 and discussed further in this section (Schlaman et al. 2005). The PMP depths calculated and discussed in this section are the average rainfall depth across the catchment areas under consideration. For smaller catchments, the PMP depths increase, as demonstrated by the following results.

2.5.1 Run 1 – Study Area A Using Model Defaults

Run 1 relied on the HMR52 Model maximizing the PMP with minimal data input. The resulting PMP was 42.71 inches. Figure 2 shows the resulting isohyets and data. The data is also summarized on Table 3.

2.5.2 Run 2 – Study Area A with a Storm Orientation of 138º

The orientation for Run 2 was determined by physical comparison of Study Area A with the storm isohyets from HMR 51 and 52. Although this orientation has the minimum moment of inertia, it does not produce the maximum precipitation because it is more than 40º off of the preferred orientation and requires an adjustment factor (see HMR 51 and 52 for further explanation). The PMP from Run 2 was 42.18 inches. The results are shown in Figure 3 as well as summarized in Table 3.

2.5.3 Run 3 – Study Area A with GIS Determined Center

Analysis of Study Area A with GIS indicated a slightly different center than the one calculated by the HMR52 Model. Run3 was made with this altered center. The change in center, resulted in a larger storm area (1,000 mi^2) but a lower total precipitation (42.15 inches) and smaller volume. The results are shown in Figure 4 and summarized in Table 3.

2.5.4 Run 4 – Study Area B Using Model Defaults

Study Area B was used to observe the impacts of a smaller drainage area on the maximized rainfall and volume totals. As shown in Figure 5 and summarized in Table 3, the smaller study area does result in an increase PMP (46.19 inches), but the total volume is lower (715,100 acre-ft). Note that this Study Area also has a significantly different orientation than the other runs.

2.5.5 Run 5 – Reservoir A-1 Using Model Defaults

As a final analysis, HMR52 was run on Reservoir A-1 by itself, to determine the depth of water that would be added to the reservoir by a PMP centered over the EAA Reservoir A-1. A total depth of 53.54 inches of rain was calculated as the PMP for the EAA Reservoir A-1. The results are shown in Figure 6 and summarized on Table 3.

2.5.6 Comparison of Results

Minor changes in orientation or centering of Study Area A do not result in large PMP depth changes. However, when multiplied by the 532 square mile drainage area, the difference in volume is more significant as shown in Table 3.

2.5.7 Recommended Design Conditions

The results from Run 1 should be used to move forward with the run-off modeling since they maximize the rainfall event for Study Area A (as shown in Figure 1) and help to determine the EAA response to a PMP across the entire region. The results from Run 5 will be used to size the reservoir embankments in the wave run-up modeling as well as determine the extents of the floodwave from a PMP breach. See the *PMP/PMF Summary Technical Memorandum (Draft)* as an example of how Run 5 was applied (Schlaman et al. 2005).

3. RUN-OFF MODEL

HEC- Hydrologic Modeling System (HMS) is designed to simulate the precipitation-runoff processes watershed systems including flood hydrology. Hydrographs produced by the program can be used in a variety of flow forecasting assessments including: reservoir spillway design, flood damage reduction, floodplain regulation, and systems operation.

When considering the EAA area, as shown in Figures 7 and 8, a typical hydrologic response is not produced. Usually, hydrology can be separated from hydraulics because the gradient of the system controls the peak flows more than the hydraulic constraints. However, the EAA system is flat and requires pumps to move excess runoff. Therefore, a typical hydrologic model such as HEC-HMS will have its limitations in predicting floodflows of a system like EAA. This is an important distinction in understanding the hydrologic response of the EAA system. Similar rain events do not necessarily produce the same watershed response because artificial controls (pumps) are affecting the results. This is the reason that coupled hydrologic/hydraulic models (i.e. MIKE-SHE) have been used in the EAA system to simulate the system response to rainfall. It was not the intent of the B&V hydrologic model to replace these more complex models, rather, it was the intent to paint a big picture concept of the response time for the system given the South Florida Water Management Districts “permitted” releases.

Shown in Table 4 is the maximum permitted release rates from each subbasin in the EAA (See Figures 9 and 10 for subbasins). If the EAA system received a PMP event it is of interest how long the system response will be. If the EAA system is responding to a PMP event for several days/weeks, the adjacent canals to the EAA Reservoir A-1 will be full with excess runoff from the farm fields. Therefore, the EAA Reservoir A-1 may not be able to release floodwater depending upon whether the downstream canals can accept more flow without causing flooding. The hydrologic model discussed here-in will investigate the response time and the conditions of the canals from various PMP events.

3.1 Design Conditions

The design conditions for the hydrologic model consisted of analyzing the various PMP storms (See Section 2) in combination with study areas defined by Figure 1. Specifically, the HMS model was used to illustrate the response time of the EAA watersheds to PMP events. Therefore, rather than listing specific “design conditions”, a series of runs will be presented and an overall outcome from the information will be detailed in Section 4.

3.1.1 Study Area

The study areas for the Run-off Model are the Study Areas detailed in Figure 1 and used in the PMP projections. The Run-off modeling was done using two separate basin models, one for each major canal: the Miami canal and the North New River (NNR) canal. These basins were defined in *EAA Basin Modeling, Task 2.2.1 - Basin and Sub-basin Delineation (*USACE, South Florida Water Management *District 2002).* Specifically, the basins defined as the “Post ECP EAA Watershed Major Basin and Sub-basin Boundaries” were used as the main basins for the HEC-HMS modeling. The Post ECP basin delineation was chosen to reflect system operation after the EAA Reservoir A-1 is constructed. See Figure 7 for a reproduction of the Post ECP basins identified in the SFWMD report. The two HMS watersheds studied are shown in this figure and consist of the NNR canal watershed and the Miami canal watershed.

3.1.2 Miami Canal Basin Model

The Miami canal HMS Model simulates runoff from subbasins M1, M2, M3, M4, M5 and B1-Miami as shown in Figure 10. The permitted releases from these subbasins are 1,253 cfs, 1,645 cfs, 1,266 cfs, 1,431 cfs, 354 cfs, and 312 cfs respectively. Table 4 provides the values stated here-in except for the B1-Miami subbasin. In the future, the B1 subbasin will be split into two halves (labeled herein as B1-NNR, B1-Miami) with part of the B1 basin draining to the NNR canal and the other to the Miami canal. Therefore, GIS was used to estimate the size of the subbasin that would drain to each watershed and a ratio of the value presented in Table 4 was taken to determine the future releases to each watershed.

3.1.3 North New River Canal Basin Model

The NNR canal HMS model simulates runoff from subbasins N1, N2, N3, N4, B1-NNR, C1, and STA 3/4 as shown in Figure 10. The permitted releases from these subbasins are 1,923 cfs, 2,378 cfs, 2,589 cfs, 1,793 cfs, 459 cfs, 853 cfs, and 167 cfs respectively. Table 4 provides the basis for the values stated here-in. In the future, the B1 subbasin will be split into two halves and the N1 and N2 subbasins will have the EAA Reservoir A-1 located within them. Therefore, the permitted release rates used in the HEC-HMS model utilized adjusted values from Table 4 by taking a ratio of the future area to the existing area. Overall the adjusted values don't significantly affect the conclusions to this task as discussed in Section 4.

3.2 Model Configuration

The HEC-HMS program was used in developing the PMF (Run-off) model. More detailed information on the HEC-HMS model, as well as documentation and model runs are included in the *Model Documentation Memorandum (Draft)* (Schlaman 2005). The model was designed to have a level of flexibility that would facilitate changes in the model as the design of the EAA Reservoir A-1 advances. For each of the five PMP depths considered in the previous section, a hydrologic response was developed utilizing the hydrological model.

HEC-HMS 2.2.2 is a graphical user interface (GUI) model. For each run, a combination of basin, precipitation, and control files are selected. The PMP precipitation depths were input in 10 minute increments to the HMS model. The control file was set to run for 60 days to simulate the long term response of the EAA watershed to a PMP event.

The basin file configuration is more complex. As discussed previously, the Miami canal and NNR canal watershed were split out separately and modeled as individual basins. As seen in Figure 11, a subbasin and storage node were used in combination to represent the hydrologic response from the EAA subbasins. The following is a discussion of the assumptions used for the basin portion of the HMS model as well as other significant variables.

3.2.1 Land Use

The EAA is mainly agricultural and sugar cane is the predominant crop. There are also some small communities located in the northern portion of the Study Area (South Bay, Fl and Belle Glade, Fl). In addition to the Miami canal and the NNR Canal, there are additional, smaller canals including: Bolles, L-3, and the western half of Cross. The area is fairly flat with little relief. Because the land is primarily agricultural the percentage of impervious land was assumed to be less than 10 percent. See Figure 8 for a regional overview of the EAA area.

3.2.2 Storage Nodes

Each EAA subbasin was modeled as a subbasin and storage node component in tandem (See Figure 11) in the HMS model. The HMS subbasins produce the excess runoff while the storage nodes act to control the maximum outflow from the subbasin in accordance with the Table 4 permitted release rates. Although, in reality, each EAA subbasin contains many smaller field pump stations, the HMS modeling was simplified by using a single storage node for each subbasin to represent the permitted maximum release rate as defined by Table 4.

3.2.3 Soil Conditions

Soil conditions have a significant impact on the run-off amount and rate from an area. Soil types in the Study area ranged from Type A to Type D, based on NRCS defintions. To provide a conservative estimate of run-off conditions, it was assumed that the local soil conditions were Type C with a moderately high run-off potential. Based on the soil type, an SCS curve value of 86 was determined for agricultural land and row crows with.

3.2.4 Run-off Lag Time

Lag times for each HMS subbasin were calculated using Manning's equation and verified as discussed in Section 3.3. It is important to note, that the lag times dramatically affect the peak flow estimates in typical hydrologic models. However, because each HMS subbasin directed its flow into a controlled storage node, the peak flows from the hydrologic model were not of much importance. For the canals, lag times for each reach were calculated using the average high flow velocity from the hydraulic model detailed in the *Hydraulic Model Summary Technical Memorandum (Draft) (*Means et al. 2005*)* and the length of reach.

3.2.5 EAA Reservoir A-1 Gates

Initially, it was thought that reservoir routing would be occurring during the PMP. However, as defined in Design Criteria Memorandum (DCM) -2 (Haapala et al. 2005b), no reservoir routing is allowed to occur during the PMP event. Therefore, the gate structures that could have affected the flows in the North New River canal were assumed not to be operating in the HMS model. This is a simplistic assumption, but the rational for this will be discussed in Section 3.5. Six gate configurations were investigated with widths ranging from 10-ft to 200-ft. However, the gate criteria used to selected appropriate gate sizes for the EAA Reservoir A-1 were mainly those regarding irrigation and environmental demands. It is anticipated that 3 separate gate structures will be used at the EAA Reservoir A-1, all of which will be approximately 50-ft wide. Utilizing gates of this magnitude, all the drawdown criteria mentioned in DCM-3 can be achieved if the downstream region is able to accept the flow (Haapala et al. 2005c). A more robust discussion of gates and selection criteria is presented in Appendix 13-1.

3.3 Model Calibration, Verification and Reliability

Direct calibration of the model is not possible since there is no historical data on a Probable Maximum Flood (PMF). However, the Crippen and Bue Maximum Envelope predicts peak flows for the area (Crippen et al. 1977). The lag times for each HMS subbasin were adjusted to reproduce peak flows within 20% of the Maximum Envelope predicted by the Crippen and Bue methodology. However, because the subbasin runoff was collected by HMS storage nodes, this calibration/verification has little impact on the overall conclusions of this memorandum.

3.4 Results

The two watersheds (Miami and NNR canal) were modeled with each of the first four PMP runs from the previous section. The additional run (5th run) was not made by HEC-HMS because it dealt specifically with the EAA Reservoir A-1 which did not need to be modeled by the hydrologic model. Each model was run for 60 days. The run-off models were run to determine the time it takes to drain the Study Area outside of the EAA Reservoir A-1. Maximum release rates for each subbasin were assumed to be applicable until the subbasins were drained. Below is a description of each run and its corresponding results.

3.4.1 HMS Run 1

Run 1 investigated the response of the EAA system to a PMP event of 42.71 inches of rain across Area A (see Figure 1). Because the NNR and Miami watersheds were separated in the HMS model, Figure 12 displays both outflow responses. The flow response displayed in Figure 12 occurs at pump stations S7 and S8 for the NNR canal and Miami watershed respectively (See Figure 8 for location of pump stations S7 and S8). If each farm area (subbasin) is allowed to pump at its permitted rate, the flows in the canals would be 9,532 and 6,418 cfs as shown in Figure 12. At these rates it will take 3-4 weeks to remove water from the farm fields. This indicates that releases from the reservoir may not be possible during the time when the farms fields are being drained following a PMP event.

3.4.2 HMS Run 2 & 3

Runs 2 & 3 investigated the response of the EAA system to PMP events of 42.18 and 42.15 inches of rain respectively across area A (See Figure 1). Because the PMP depths are nearly identical, the resulting HEC-HMS model output is extremely similar. Therefore, Figure 13 is used to represent the output from the HMS model for both runs. Graphically, the results would not be different enough to notice a change. The flow response displayed in Figure 13 occurs at pump stations S7 and S8 as labeled on Figure 8. If each farm area (subbasin) is allowed to pump at its permitted rate, the flows in the canals would be 9,532 and 6,418 cfs as shown in Figure 13. At these rates it will take 3-4 weeks to remove water from the farm fields. This indicates that releases from the reservoir may not be possible during the time when the farms fields are being drained following a PMP event. The main difference between these two runs and Run 1 is that the response from the system does not occur as long because less volume falls across the watershed However, the reduction in volume was only about 1.3%, so the overall response time for the system is only 1.3% shorter than Run 1.

3.4.3 HMS Run 4

Run 4 investigated the response of the EAA system to PMP event of 46.19 inches of rain across area B (See Figure 1). The depth of the PMP is increased because the area of interest was reduced. Furthermore, because the area of interest was reduced, the subbasins in both the NRRC and Miami HMS models area were adjusted accordingly to only represent those areas in which the PMP fell on. The flow response displayed in Figure 14 occurs at pump stations S7 and S8 for the NNR canal and Miami watersheds respectively (See Figure 8 for location of pump stations). If each farm area (subbasin) is allowed to pump at its permitted rate, the flows in the canals would be 7,743 and 4,164 cfs as shown in Figure 14. At these rates it will take 3-4 weeks to remove water from the farm fields. This indicates that releases from the reservoir may not be possible during the time when the farms fields are being drained following a PMP event. The main difference between this run and the others is that it investigates a PMP storm falling over a smaller area. Since the PMP depth increased, the response time for affected subbasins is also increased, but the overall peak flow is reduced because subbasins once included in the PMP event are no longer affected.

3.4.4 HMS Run 5

Although no HMS model run was created for Run 5, this scenario is still of interest. This condition defined the rainfall depth if a PMP storm were to occur only over the EAA Reservoir A-1 (shown in Figure 1). This run developed the 53.54 inches PMP depth used in other EAA reports such as the wave run-up and dam breach modeling. Because the EAA Reservoir A-1 doesn't have a watershed except for its surface area, the PMP depth can be added to the depth of water in the reservoir to determine the total depth of water resulting from a PMP storm. No watershed response is detailed in this situation because the EAA Reservoir A-1 was the only component receiving rainfall.

4. SUMMARY AND CONCLUSIONS

A PMP storm is capable of producing 42.71 inches of rain over the EAA region and 53.54 inches of rain over the EAA Reservoir A-1. While the 53.54 inches should be used to determine the A-1 embankment height and extents of a dam breach, the 42.71 inches is viewed as a storm that could inundate the entire area identified in Figure 1 as “Area A”. Intermediate PMP storms between these two values can also occur where only portions of the studied area are inundated (Area B). This fact affects the EAA Reservoir A-1 in several ways. First, if a large storm where to occur, it has been shown that the area will take weeks to respond to the flood flows. If in the future, when all EAA excess runoff is hoped to be passed to the South, the system appears to be undersized in relation to the current permitted release rates. Therefore, if the reservoir and surrounding region were to be inundated by a large storm, excess conveyance capacity in the canals will be in high demand. Flood releases from the EAA Reservoir A-1 may not be able to be passed into the canals because of downstream flooding concerns. Therefore, if the EAA Reservoir A-1 needs to be drawndown quickly following a large event, either farm releases will have to cease or the reservoir surcharge will need to be passed directly into STA 3/4. Furthermore, this illustrates the need for the SFWMD to evaluate its current priorities when dealing with flood discharges. A combination of farm and EAA Reservoir A-1 releases to the adjacent canals may be possible, but not at the rates that the current permitted capacities of the EAA subbasins dictate. Unless modifications are made to the canals and pump stations, flood releases will be governed by the existing system components, further slowing down the response time of the EAA system. Based upon the findings presented in this report, quick drawdowns from the EAA Reservoir A-1 following a PMP event will be more controlled by District operational regulations than by the physical aspects of releasing flow. Proposed gates at the EAA Reservoir A-1 will have adequate capacity to meet the range of operational needs.

5. REFERENCES

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TABLES

Table 1 Study Area Summary

Study Area Name	Area (mi^2)	Study Area Center	
		x-coordinate	y-coordinate
A	532	733,968	787,409
B	290	736,649	791,018
A-1 Reservoir	24.9	769,969	764,016
Note: Coordinates based on Florida State Plane East NAD83 (HARN), feet			

Table 2 PMP Comparison

Report Name	Location/Description	72-hr PMP (inches)
Levee High Report (CERP 2004)	EAA Area	53.8
DCM-2 (Happala et al. 2005)	EAA Area	55-60

Table 3 Summary of PMP Model Results

Model	Storm Area (mi^2)	Storm Orientation	Total Precipitation (inches)	Total Volume (acre-ft)
Run 1	700	155	42.71	1,212,600
Run 2	700	138	42.18	1,198,900
Run 3	1,000	155	42.15	1,195,500
Run 4	300	283	46.19	715,100
Run 5	50	150	53.54	71,100

Table 4 Permitted Drainage Capacities for EAA Subbasins
Obtained from *B.2 Basin Modeling, B.2.2.2 Inventory of Sub-Basin Data*

Ag Basin	Total Permitted Drainage Capacity, cfs (Pump Out)	Total Permitted Irrigation Capacity, cfs (Pump In)
B1	771	125
C1	853	544
C2	1,637	692
H1	5,354	1,631
H2	1,497	692
H3	757	134
M1	1,253	58
M2	1,645	784
M3	1,266	905
M4	1,431	420
M5	354	0
N1	1,923	624
N2	2,378	1,089
N3	2,589	307
N4	1,793	1,114
O1	882	828
O2	1,953	1,430
O3	3,486	865
W1	2,941	1,404
W2	4,300	1,352
W3	0	0
STA-3/4	167	0
Total	39,230	14,998

FIGURES

Figure 1 PMP Study Area

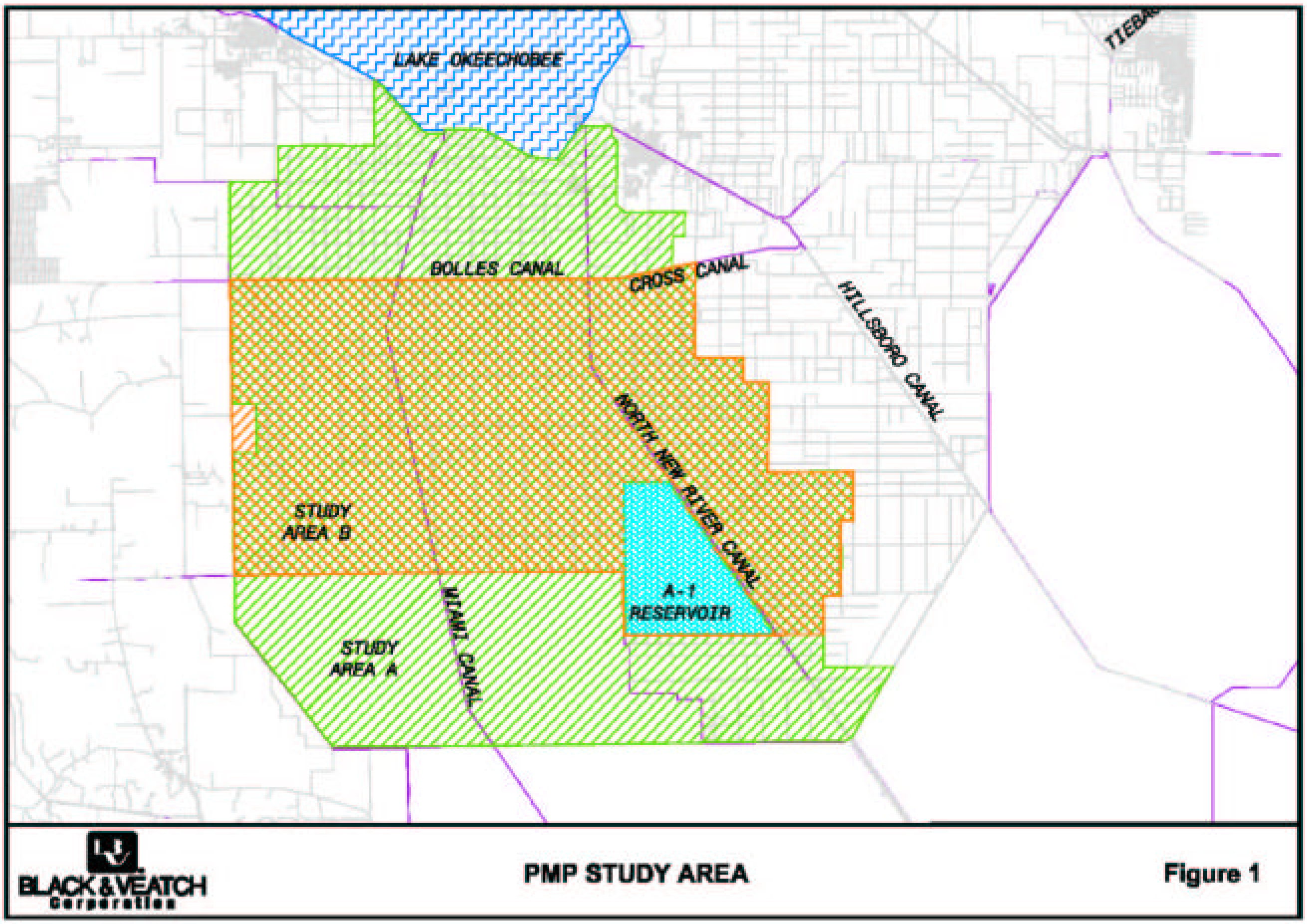


Figure 2 PMP Run 1

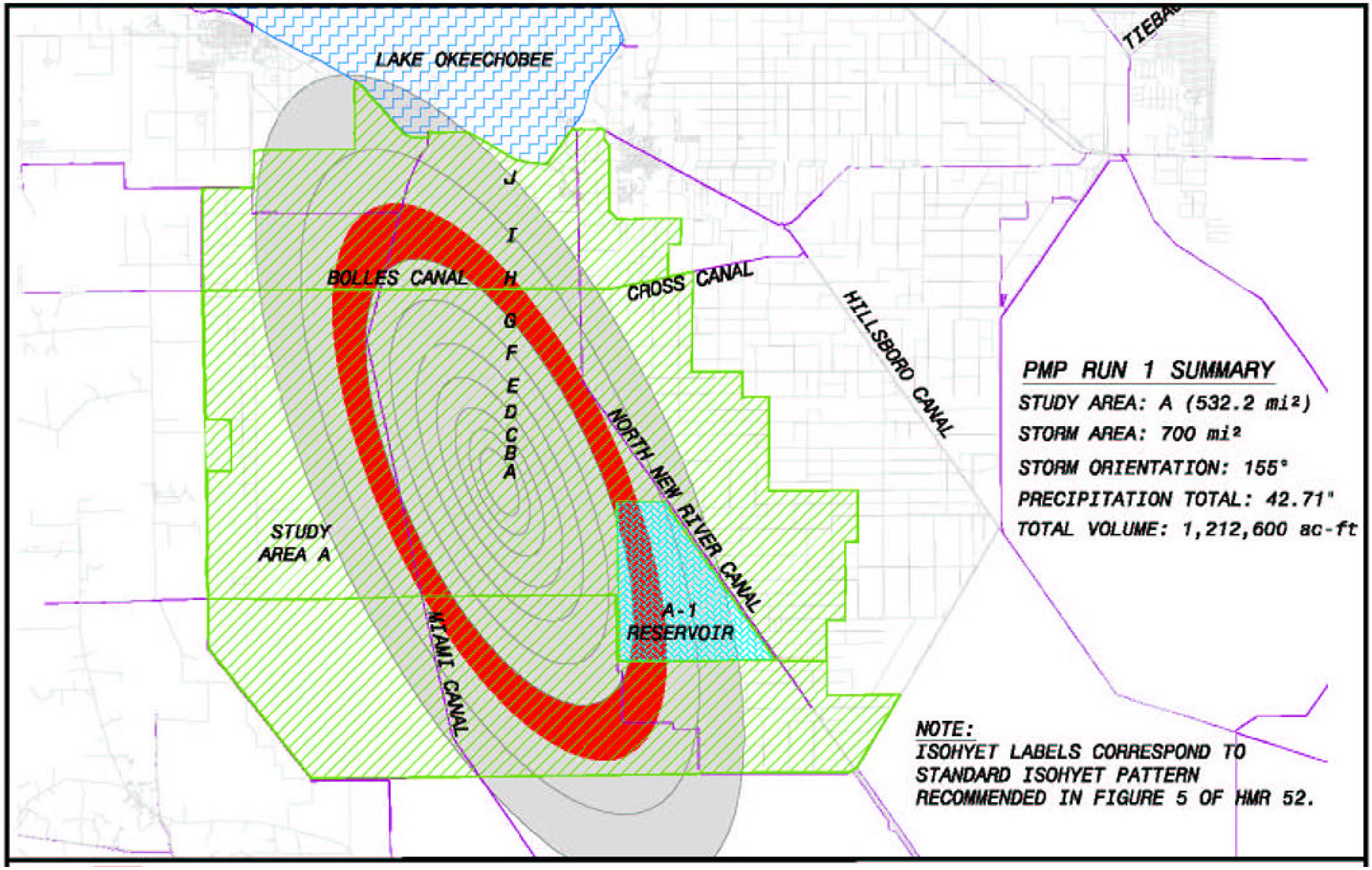


Figure 3 PMP Run 2

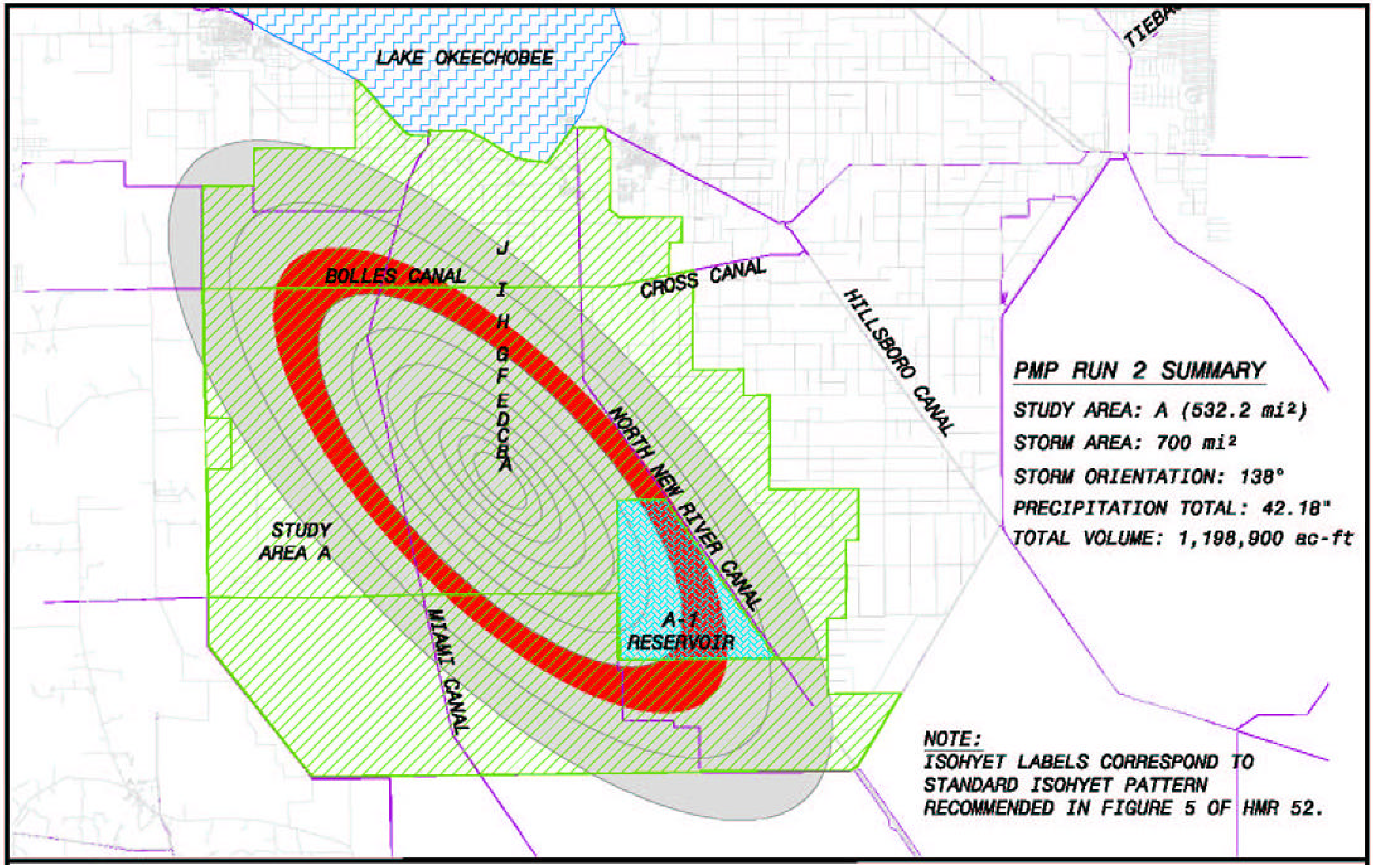


Figure 4 PMP Run 3

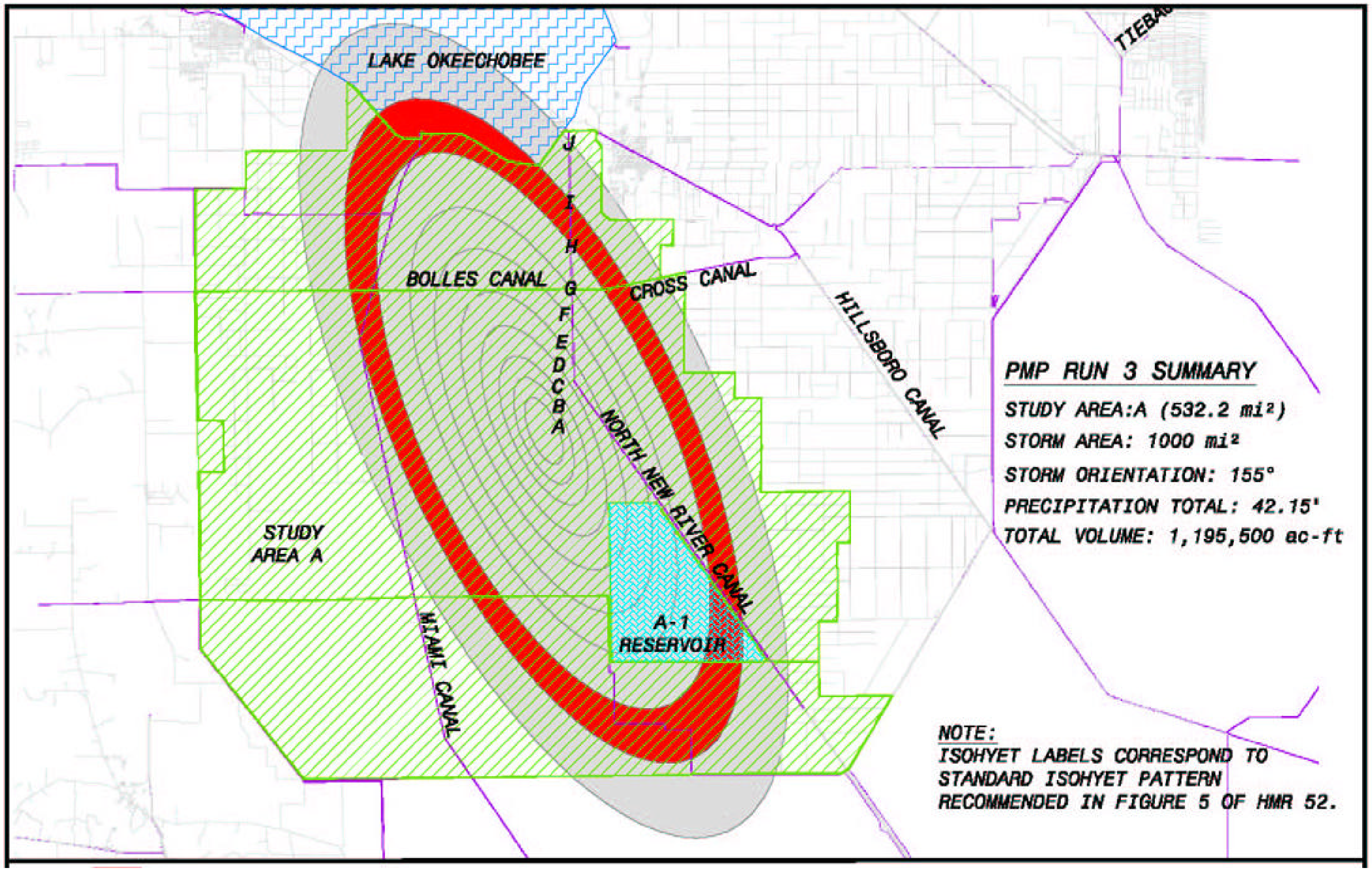


Figure 5 PMP Run 4

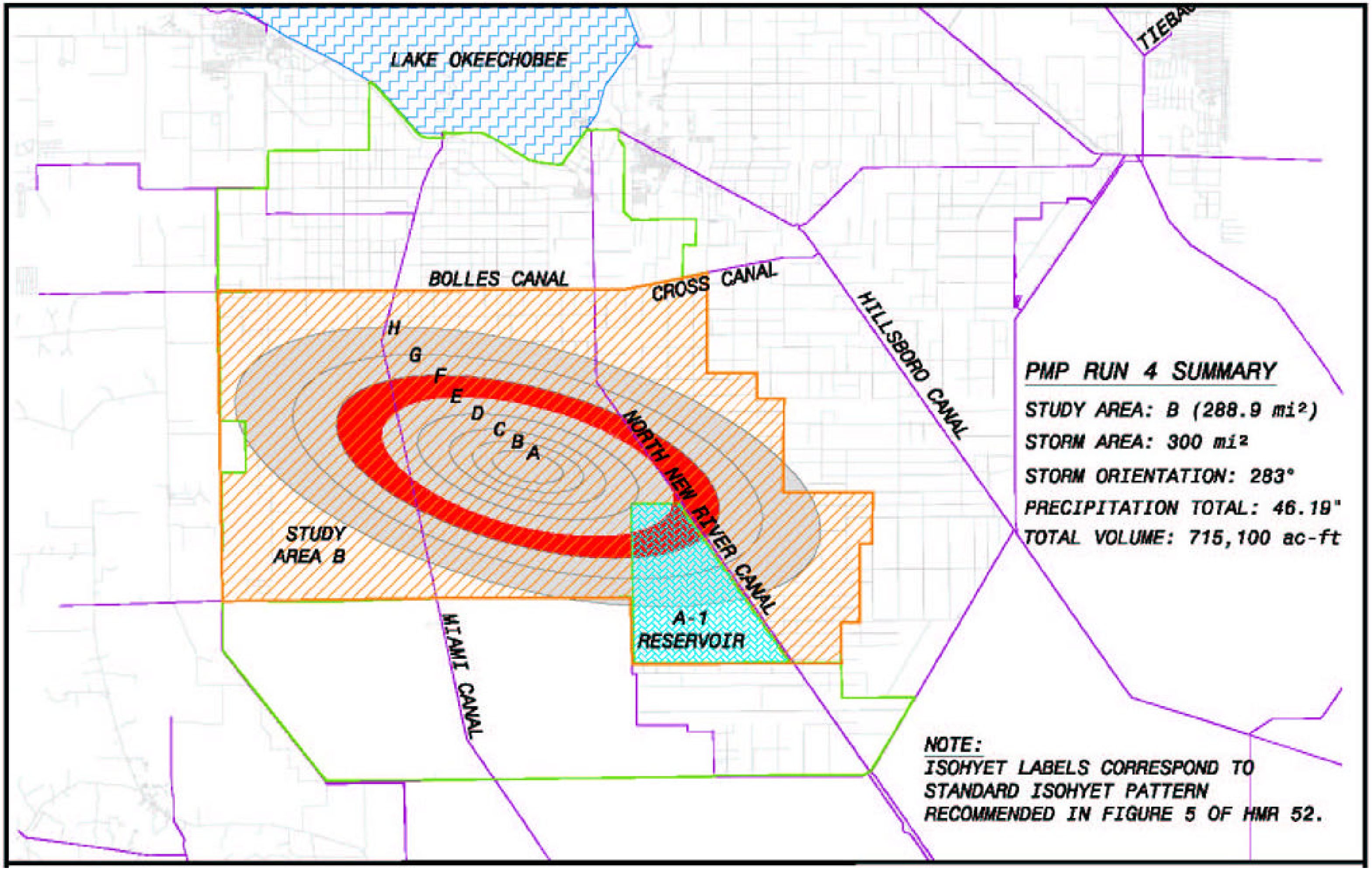


Figure 6 PMP Run 5

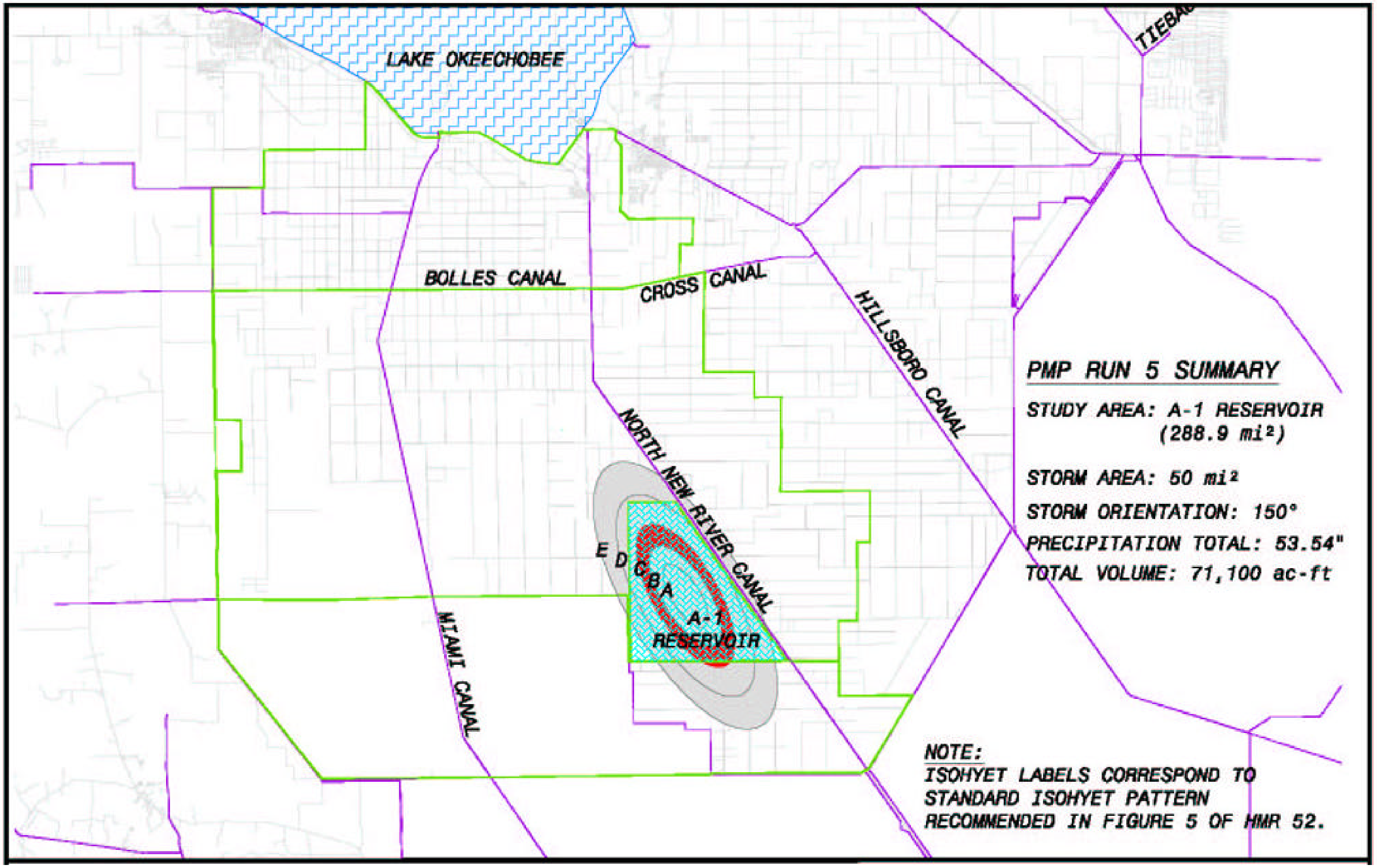
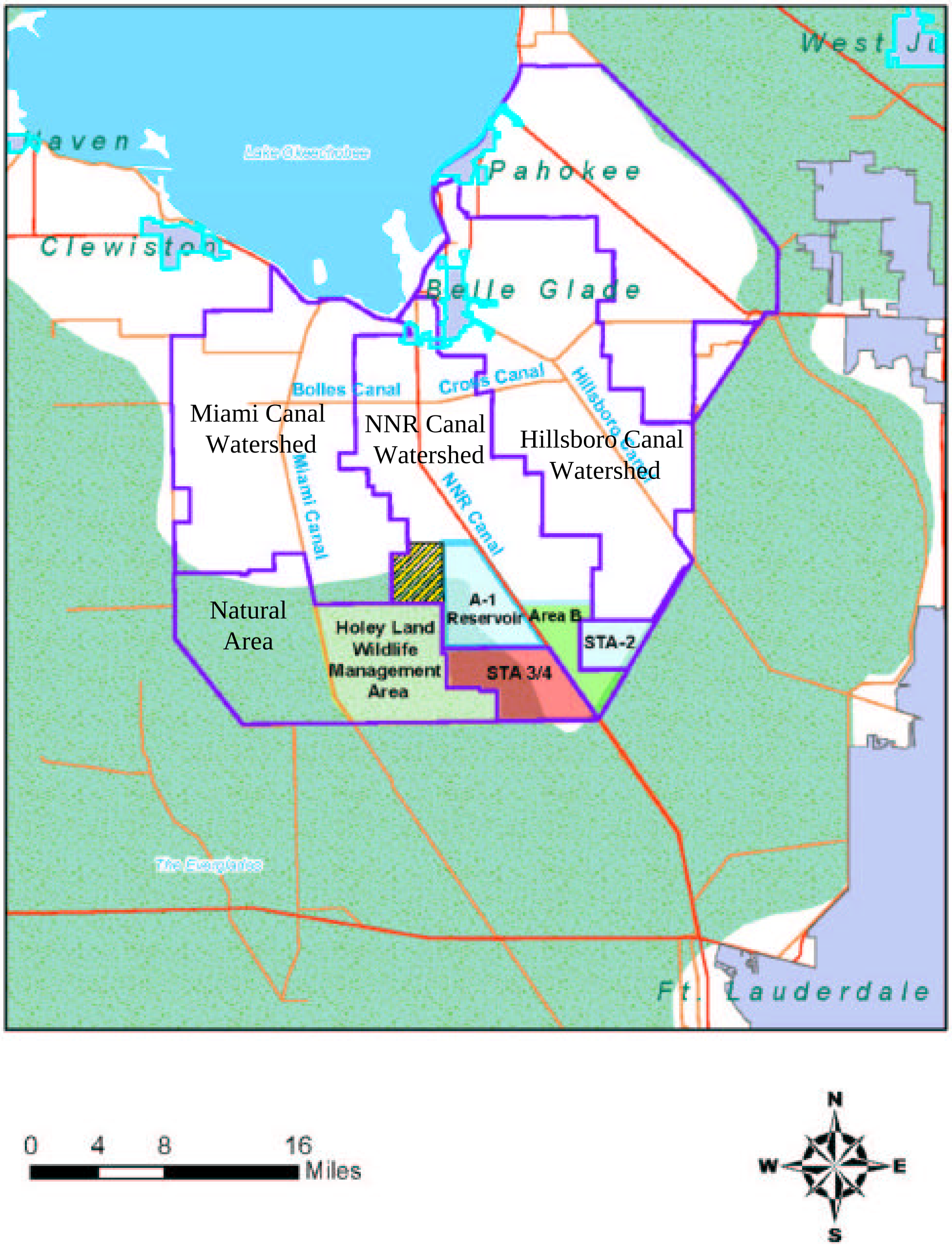

LAKE OKEECHOBEE
BOLLES CANAL
CROSS CANAL
HILLSBORO CANAL
NORTH NEW RIVER CANAL
MIAMI CANAL
E D C B A
A-1 RESERVOIR
PMP RUN 5 SUMMARY
STUDY AREA: A-1 RESERVOIR (288.9 mi²)
STORM AREA: 50 mi²
STORM ORIENTATION: 150°
PRECIPITATION TOTAL: 53.54"
TOTAL VOLUME: 71,100 ac-ft
NOTE:
ISOHYET LABELS CORRESPOND TO STANDARD ISOHYET PATTERN RECOMMENDED IN FIGURE 5 OF HMR 52.

Figure 7 EAA Site Overview and Major Watersheds



(Reproduced from *Task 2 - EAA Basin Modeling, Task 2.2.1 - Basin and Sub-basin Delineation. Phase I Project Implementation Report*)

Figure 8 Regional Overview of EAA

Obtained from *Everglades Agricultural Area Storage A-1 Levee Optimization: Report for Conceptual Levee High Alternatives*

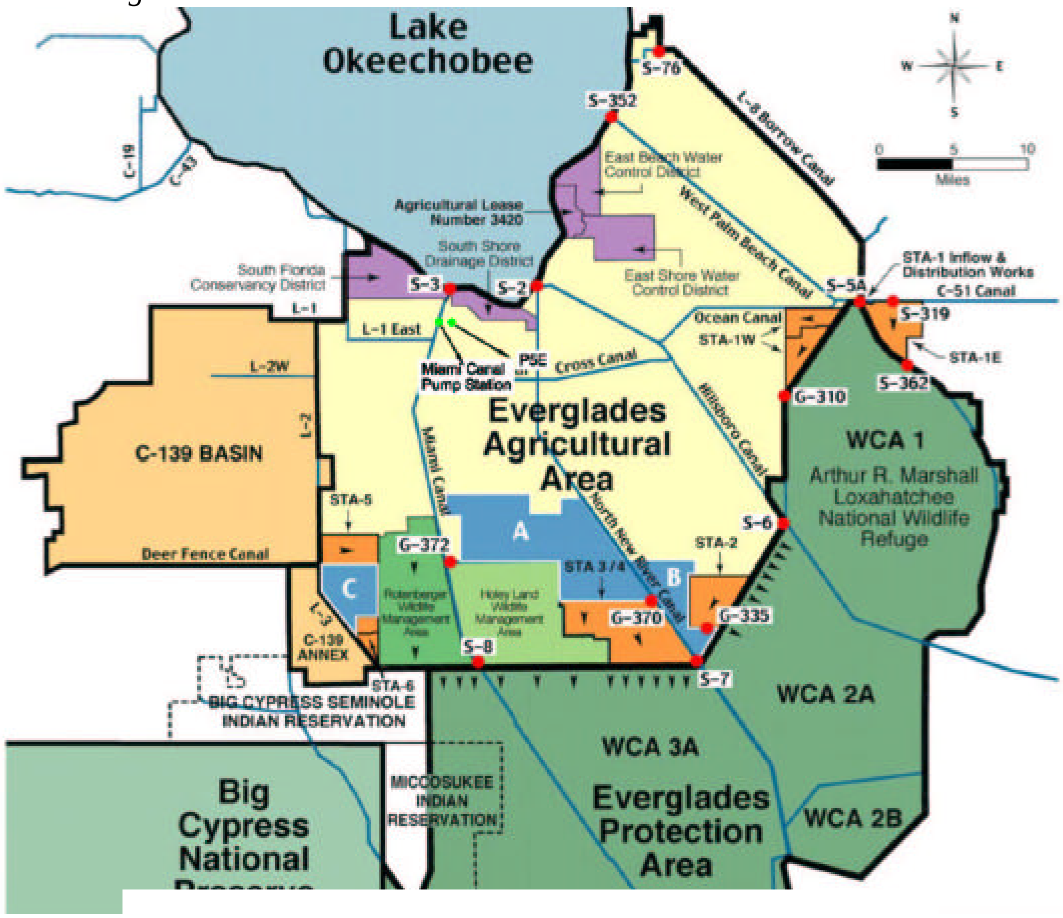
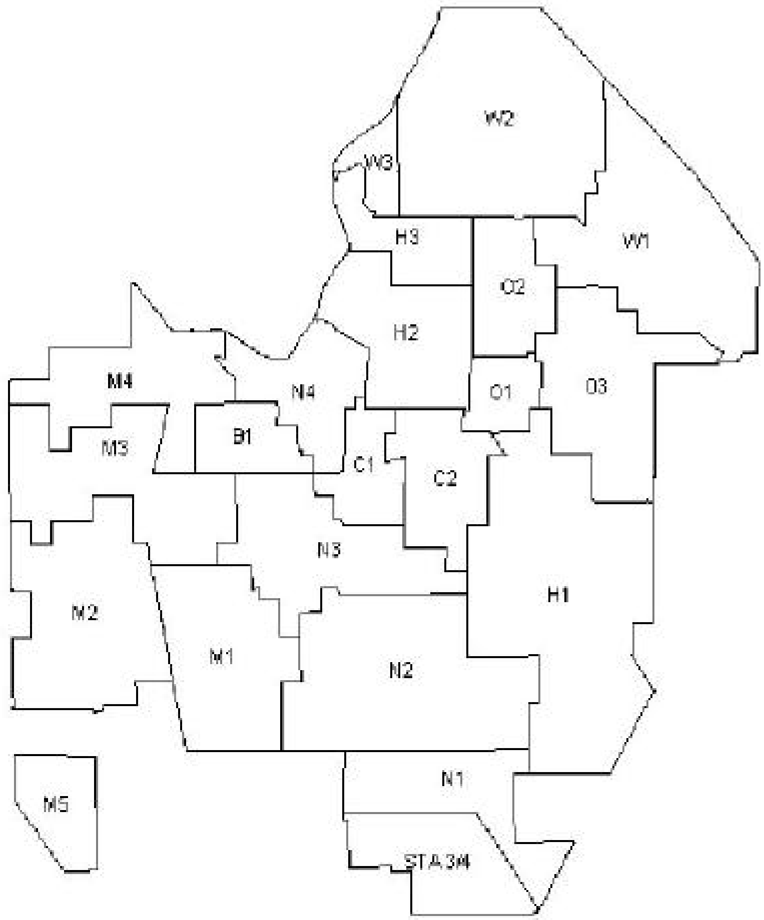


Figure 9 EAA Subbasins



Obtained from *B.2 Basin Modeling, B.2.2.2 Inventory of Sub-Basin Data*

Figure 10 EAA Subbasins and Watersheds

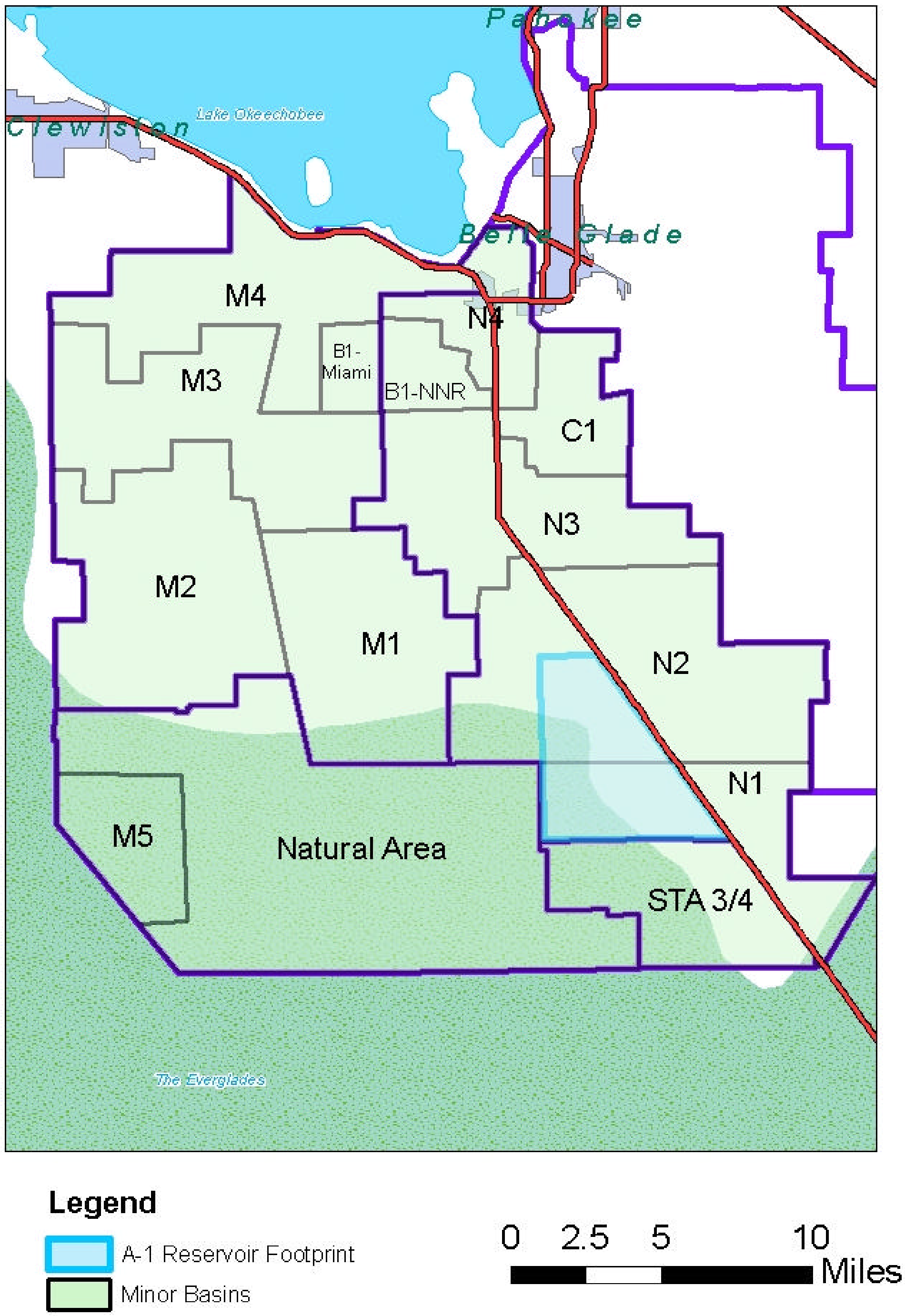


Figure 11 HEC-HMS Model Schematic

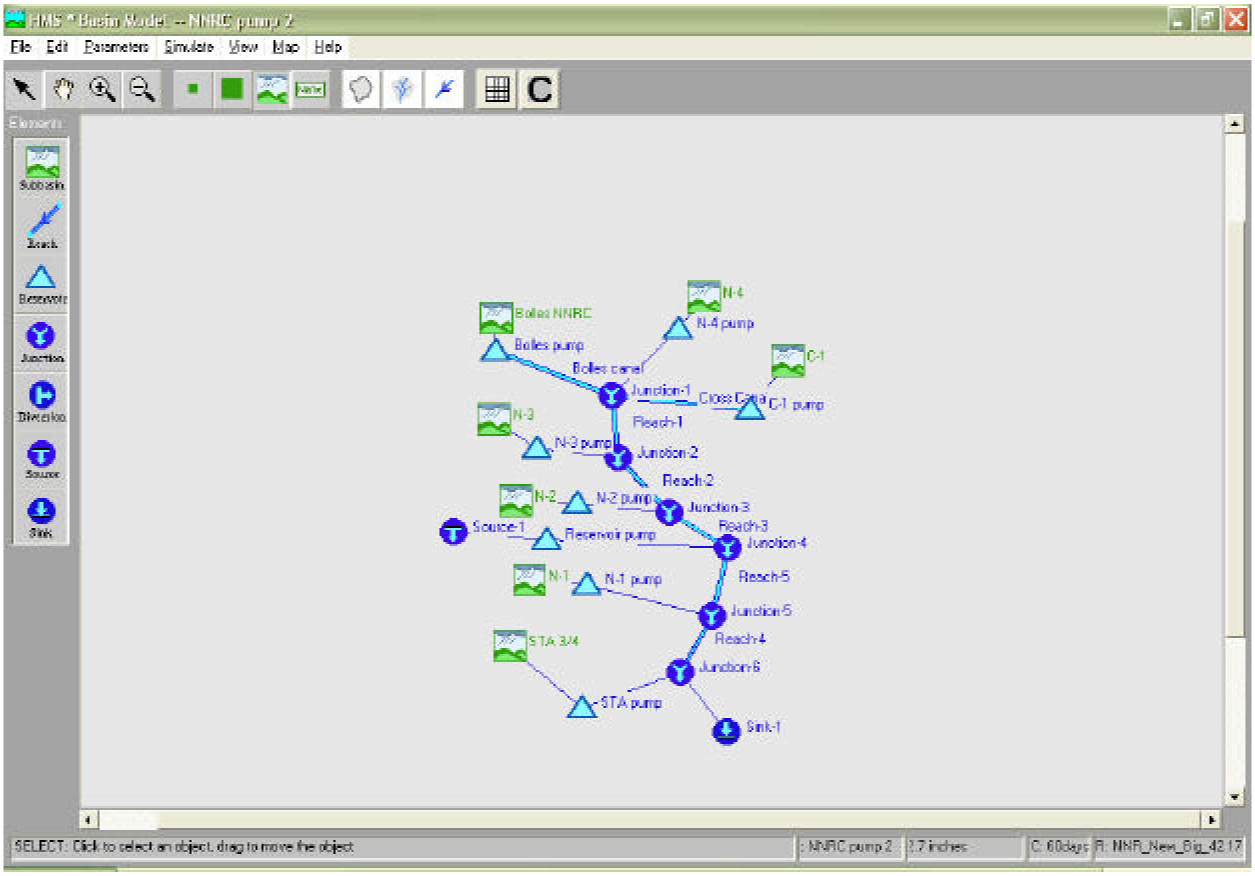


Figure 12 Results of HMS Run 1

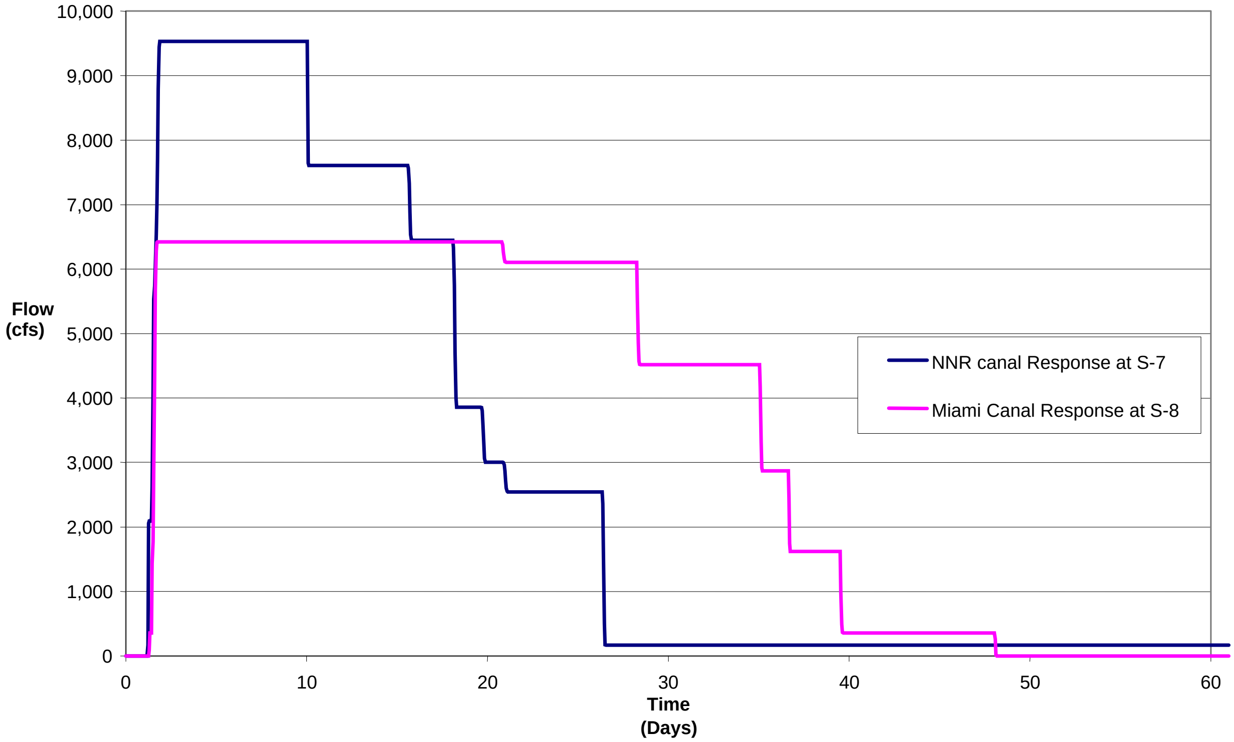


Figure 13 ` Results of HMS Run 2 & 3

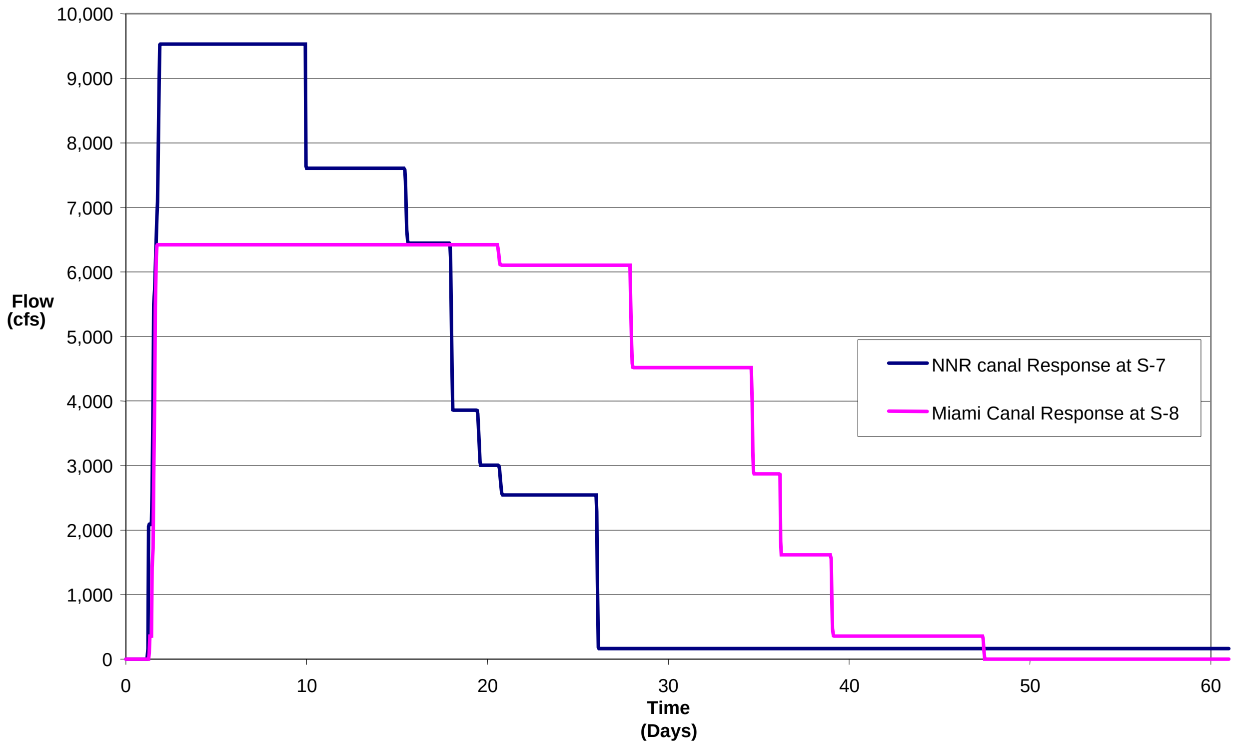


Figure 14 Results of HMS Run 4